FOREWORD

This issue of the *ICF Quarterly Report* has seven articles detailing progress in the Inertial Confinement Fusion (ICF) program at Lawrence Livermore National Laboratory (LLNL). The progress includes improved understanding of capsule implosions and laser–plasma coupling, new direct-drive capsule designs for the National Ignition Facility (NIF), modeling of high-power *Z* pinches as novel x-ray sources, and advances in laser science. This work both illustrates and advances our expertise for applications of high-power lasers and advanced computer models for inertial fusion and other defense science applications.

Ongoing experiments and modeling continue to refine our understanding of the target physics required for optimal target designs for inertial fusion and other applications. As discussed in "X-Ray Backlit Imaging of Indirect-Drive Capsule Implosions" on p. 68, x rays have been used to backlight an imploding capsule with 55-ps temporal and 15-μm spatial resolution. Both the in-flight aspect ratio of the ablator and the radial-density profile in the capsule are measured as a function of time and used to benchmark the models. An improved scaling for stimulated Raman scattering (SRS) of laser light is reported in "Interaction between Stimulated Raman Scattering and Ion-Acoustic Waves in Ignition-Relevant Plasmas" on p. 73. The reflectivity due to SRS is shown to depend on the ion wave damping, indicating instability saturation by a decay process involving ion waves. These experiments are consistent with modified electron velocity distributions, which significantly reduce Landau damping of the electron-plasma waves. Changes of the velocity distributions due to nonlocal heat transport and inverse bremsstrahlung absorption are discussed in "Effects of Non-Maxwellian Electron Velocity Distributions on Parametric Instabilities" on p. 78. The self-consistent changes in the frequency and damping of electron–plasma waves and ion sound waves are calculated as a function of the modified distributions. Finally, in "Laser-Beam Deflection Induced by Transverse Plasma Flow" on p. 63, the laser is steered in the transverse flow direction by refraction into density depressions swept downstream by the flow. Such a deflection affects irradiation symmetry in gas-filled hohlraums, as demonstrated in recent experiments on Nova. Theoretical analysis shows that filamentation or forward Brillouin scattering in flowing plasma causes this deflection, and the amount of deflection, which is mitigated by temporal beam smoothing, is quantified by 3D simulations of wave–plasma interactions.

In two articles, we investigate direct-drive target designs for NIF as well as high-power *Z* pinches as potential x-ray sources for various applications. In "Direct-Drive Capsules for NIF" on p. 43, directly irradiated capsules that could achieve ignition using NIF are examined. It is shown that suitable beam geometry and acceptable beam pointing accuracy and power balance can be achieved. LASNEX simulations provide the beam-smoothing requirements and indicate that the Rayleigh–Taylor (RT) instability is tolerable. In "Modeling of High-Power *Z* Pinches" on p. 86, 2D radiation magnetohydrodynamics simulations are used to show that the RT instability is important in limiting the achievable power density of these imploding pinches. Potential control mechanisms, such as tailoring the initial density distribution, are identified.

Finally, new developments in high-average-power laser technology are reported in "Taking Average-Power, Diode-Pumped, Solid-State Lasers beyond the Nd^{3+} Ion" on p. 52. In particular, we have demonstrated more than 100 W of CW output from a compact, efficient, reliable diode-end-pumped Tm:YAG laser system, as well as up to 434 W of CW power from an end-pumped Yb:YAG laser system. The unique capabilities of these two systems are detailed.

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